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A Proposed Series of Projects to Evaluate the Potential Physical, Biological and Water Use Impacts of Water Withdrawals and Water Development on the Middle and Lower Portions of the Yellowstone River Drainage, Montana

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December 1973

Prepared By The

Montana Energy Advisory Council

For Submission To The

Old West Regional Commission

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OUTLINE SUMMARY OF PROPOSAL

I. Title: A Proposed Series of Projects to Evaluate the Potential Physical, Biological and Water Use Impacts of Water Withdrawals and Water Development on the Middle and Lower Portions of the Yellowstone River Drainage, Montana.

II. Tentative Investigators:

Montana Energy Advisory Council (coordinating role)
Montana Department of Natural Resources and Conservation
Montana Department of Fish and Game
Montana Department of Health and Environmental Sciences
(Water Quality Bureau)
Montana Department of Agriculture
Montana Environmental Quality Council
Montana University System (active and supporting roles)

III. Objectives:

A. To obtain information sufficient to analyze the consequences of water storage and diversion at various locations, under a wide variety of stream flow conditions on the following:

1. Fish populations and other aquatic communities.
2. Irrigation - dependent agriculture (present and projected).
3. Municipal and industrial (other than energy) consumption of water (present and projected).
4. Surface water quality.
5. Water-based recreation.
6. Existing hydrologic systems.

B. To calibrate and utilize the mathematical model developed by Montana State University for the Montana Department of Natural Resources and Conservation to simulate flow conditions in the middle and lower Yellowstone Basin under various predetermined conditions.

C. To estimate under various stream flow conditions value of alternative water uses possibly foregone or affected as a result of energy development.

IV. Project Study Area: A map of the area of investigation is included with this proposal as Appendix A. The area includes the following sub-major and minor drainage basins indentified in the Atlas of Water Resources in Montana by Hydrologic Basin, Inventory Series Report No. 11, Montana Department of Natural Resources and Conservation. Appendix B shows areas underlain by Fort Union coal in Eastern Montana.

Middle Yellowstone (Sub-Major Drainage Basin)

Minor Drainage Basins

43E	Pryor Creek
43N	Shoshone River
43O	Little Bighorn River
43P	Bighorn River below Greybull River
43Q	Yellowstone River between Clarks Fork Yellowstone and Bighorn River
42A	Rosebud Creek
42B	Tongue River above and including Hanging Woman Creek
42C	Tongue River below Hanging Woman Creek
42KJ	Yellowstone River between Bighorn River and Tongue River

Lower Yellowstone (Sub-Major Drainage Basin)

Minor Drainage Basins

42I	Little Powder River
42J	Powder River below Clear Creek
42K	Yellowstone River between Tongue and Powder River
42L	O'Fallon Creek
42M	Yellowstone River below Powder River

V. Background: Water may be the limiting natural resource in the conversion of coal to various other forms of energy in eastern Montana. Moreover, water has and will continue to have value for other human uses and is essential in maintaining natural systems which are an integral part of the ecologic framework of the Northern Great Plains.

Introduction

Coal reserves impose few, if any, immediately foreseeable limits on energy-based industrial growth in the Northern Great Plains. Over 42 billion tons of economically strippable coal reportedly underlie just the Montana portion of the Fort Union Basin.*/ As further studies are completed, known strippable reserves will surely increase. Excepting export of the coal itself, there are no significant competing uses for coal destined for mine site conversion facilities.

Water, the second major raw material delivered to energy conversion facilities, is essential to almost every other human endeavor. On occasion, this resource comes in very short supply. Water availability problems, unrelated to industrial consumption, already limit economic growth in the region. Further, it is recognized that water is essential for maintaining those natural systems upon which men depend for health, relaxation and spiritual well-being.

Therefore, if the emerging coal-related energy industry withdraws and consumes large quantities of water from this semi-arid

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*/ Montana Bureau of Mines and Geology.

region, other uses of water may be limited or precluded and water quality and aquatic populations may be seriously affected. Little is known about the consequences which various methods, timing and levels of withdrawals may have upon irrigation, agriculture, municipal water supplies, water-based recreation, water quality, fisheries and other aquatic life.

Purpose

The objectives of the proposed project are to:

1. Gather baseline information sufficient to identify and quantify the potential consequences of energy-related water consumption to all major competing uses for water in the Montana portion of the Yellowstone Basin;
2. Determine what resource and ecological impacts may result from different configurations of water development and consumption; and
3. Evaluate costs and benefits resulting from such impacts.

The studies are field oriented. They are designed to use and extend the work of the Water and Surface Resources Work Groups of the Northern Great Plains Resource Program (NGPRP).

The concerns addressed are common to all five states of the Old West Regional Commission. Neighboring states may wish to modify these ideas to fit their needs and concerns. As similar projects are undertaken in other states, interstate work can be

coordinated with significant savings from economies of scale. If this approach is taken, the coordination section of this proposal should be rewritten to conform to multi-state needs.

Water Use

Large water storage projects (on and off stream) and major diversions are being planned, proposed or speculated upon; the most significant documentations relevant to the Montana study area follow:

A. Montana-Wyoming Aqueduct Study. This report, prepared by the U.S. Bureau of Reclamation in April, 1972, presents ". . . a potential water resource project in southeastern Montana and northeastern Wyoming." More specifically, the report identifies

> ". . . water resources of the study area that may be available for development of the vast coal resources of the Region and presents results of studies of an aqueduct system and alternatives, that would be required to convey water from sources to points of possible use."

Some findings and conclusions of this report are: (1) projected industrial demands of water by future industry are 2.6 million acre feet; and (2) construction of mainstream or offstream storage to firm flows on the Yellowstone River will be required together with the construction of large capacity aqueducts.

The National Petroleum Council's report entitled U.S. Energy Outlook, dated December 1972, accedes to the conclusion of the Aqueduct Study, stating:

> "Completion of the Montana-Wyoming Aqueduct, or other projects of comparable magnitude will be required if the large energy developments projected in Wyoming are to be satisfied. Smaller projects requiring less time for completion could serve the projected requirements in Montana, North Dakota and South Dakota."

B. Big Horn (Yellowtail) Reservoirs. The Bureau of Reclamation has signed contracts with industrial firms for options on 623,000 of a possible 670,000 acre feet of available water. These options have not yet been exercised.

C. Tongue River Reservoir. An option on 4,175 acre feet of water has been negotiated with the State of Montana by the Montana Power Company. This is the only water allocated to industrial uses from the reservoir, however, the feasibility of raising the Tongue River Reservoir has been studied together with the alternative of a higher dam downstream from the present site. In either case, an additional 60,000 acre feet of water could be provided.

D. Colstrip Thermal Generation Units. To provide cooling water to the 2,100 megawatt coal-fired generation facility, Montana Power Company proposes to withdraw 39,000 acre feet per year from the Yellowstone River.

E. Intake Water Company. On June 8, 1973, Intake Water Company filed a notice of appropriation of 80,650 acre feet per year from the Yellowstone River in Dawson County, Montana. Intake intends to sell, rent and distribute the water to various water users for irrigation, industrial, municipal and domestic purposes, including companies with energy generating or conversion plants within or

outside the State of Montana for use in the operation of such energy generating or conversion plants.

F. Basin Electric Power Cooperative. On June 29, 1973, Basin Electric Cooperative filed a notice of appropriation for approximately 50 cfs (36,200 acre feet per year) of water from the Yellowstone River near Forsyth, Montana. The intended use of this water is for the operation of a steam electric generating station. Should Basin Electric choose an alternative site in Wyoming, it is anticipated that their Yellowstone Basin water demands would remain constant.

G. Utah International, Inc. Utah International is planning to construct four 250,000,000 cubic feet per day coal gasification plants by the early 1980's near Moorhead, Montana. State water authorities in both Wyoming and Montana have been contacted about the appropriation. Utah International is studying offstream storage of Powder River water in Wyoming above the Moorhead dam site. A privately financed interstate aquaduct would divert 80,500 acre feet of water annually to the gasification facilities.

H. Other Water Use Studies.

1. Three work groups (National Energy Needs, Water, and Mineral Resources) of the Northern Great Plains Resource Program will contribute to a June 30, 1974, updated projection of energy development water needs in the Northern Great Plains. Three sets of data, corresponding to three possible levels of coal-industrial development (scenarios), will be available on or before that date.

Preliminary calculations, presently under revision, indicate that less than 2.6 million acre feet per year level of consumption will not be realized by the year 2000. About half that volume is anticipated.

2. Professor Richard Stroup of Montana State University is conducting an OWRR financed investigation of "Demands for the Use of Water in Coal Development." Recent additional assistance from the Northern Great Plains Resource Program allows the expansion of this work to include dry cooling feasibility studies for power plants in the Northern Great Plains. Stroup's work will provide a range of increased capital, operational and maintenance costs attributed to installation of dry cooling equipment as compared to conventional evaporative cooling methods. The OWRR grant will result in an ideal companion study for this proposed project. The latter will evaluate "opportunity costs" of water consumption; the former, the economics of avoiding much of the opportunity costs.

3. Doctors Maxine Johnson and Paul Polzin of the University of Montana, similarly funded by OWRR, are studying the economic impacts of water use and coal development in Eastern Montana. Their work will be extremely valuable in finalizing the economic analysis framework discussed in later sections of this proposal.

General Methodology

Most observers conclude that the present "information pyramid" for water use questions is upside down. There are many analysts, state, federal, corporate and concerned citizens anxious to evaluate the extent to which new water uses will negate or compete with old

uses. Many bravely predict consequences from "disasterous" to "no problem at all."

In contrast, there are few investigators in the field gathering data for analysts to interpret. Phase I of this proposal is devoted to field studies.

It is evident that one cannot evaluate a dam's impact upon fisheries until the fish habitat needs are known and understood. Preliminary fisheries studies on the middle Yellowstone found eight fish species previously unknown in the river. Similarly, one must document how irrigators fared during the low flows of the early sixties if we are to predict the consequences of reducing future flows. (One irrigator's views are attached as Appendix C).

Because of the wide spectrum of possible impacts associated with energy development in the Yellowstone Drainage and tributaries, it is essential that any impact evaluation account systematically for a diversity of complex and interrelated impacts. To assess the water use impacts on resources, living organisms, and people requires a wide range of talent and disciplines. We propose the following interdisciplinary studies be undertaken:

Phase I - Information Gathering. This phase would consist of several individual investigations, each capable of being carried out independently, yet providing information valuable to the other sub-studies. These individual, baseline investigations are intended to obtain the needed understanding, measurements and indicators to enable impact predictions to be made. All investigations "stand

alone," i.e., any one could begin and provide needed information independent of the status of the others. Each investigation has been repeatedly identified by Montana State Government as a priority study necessary for the identification and evaluation of possible impacts.

Phase II - River Basin Model Calibration and Simulation and Impact Evaluation. A logical extension of the knowledge gained in Phase I is to use this knowledge to predict, under various sets of water flow and water development assumptions, the water requirement conflicts that may arise. The simulation model may also prove useful in mediating the conflicting demands through a series of priority levels based upon legal rights and community desires.

Phase III - Economic Evaluation. This phase would synthesize selected findings of Phases I and II and attempt to quantify, through the use of economic analysis, the water use conflicts and tradeoffs arising among various water uses and users and natural systems.

These three phases and the investigations required under each phase can be described in the following manner:

Phase I - Information Gathering

- Aquatic Community Investigation
- Irrigation Agriculture Water
- Municipal Water Needs
- Water Quality
- Water Based Recreation
- Hydrologic Considerations

Phase II - River Basin Model Calibration and Simulation and Impact Evaluation

- Data Preparation, Model Calibration and Simulation Runs
- Impact Evaluation

Phase III - Economic Evaluation

- Continuous Consultation With Phases I and II
- Expression of Various Consequences in Economic Terms

Detailed Methodology

Phase I - Information Gathering. Areas of principle concern, where further understanding is needed to predict impacts resulting from river flow changes are:

1. Aquatic communities.
2. Irrigation dependent agriculture.
3. Municipal and non-energy related industrial water needs.
4. Water quality.
5. Water based recreation.
6. Hydrology.

Baseline data will be collected in each specific area to enable investigators to make predictions concerning possible consequences resulting from changes in stream flow. Each individual investigation will produce a usable report for Phase II of the study, river basin simulation and impact evaluation.

Each investigation will be coordinated with the resource economist of the Phase III sub-project so that parameters useful to a concluding scenario/analysis will be identified and quantified.

Fish and Wildlife Ecology - Yellowstone River

The Yellowstone River from its source in Yellowstone Park, Wyoming, to its confluence with the Missouri River in North Dakota represents one of the last major rivers on earth functioning as a free-flowing system attuned with the plant and animal communities

associated with it. Along with streams draining into it, primarily from the south, it represents in many respects the key to the type and magnitude of developments that can be accomodated in Wyoming, Montana, North Dakota and South Dakota. Its wildlife resources are critically important to the people of all the states party to the Old West Regional Commission, either as residents living in harmony with the river or as guests from other states utilizing the river's nationally renowned amenities and productive capacity.

Today little is understood about the relationship between the natural functioning of the river and its associated plant and animal communities. Data with which to meaningfully assess the impact of altering the present relationship are clearly lacking.

This proposal begins striving for understanding. It does not expect to present in the short term a clear and total comprehension, but it does provide an approach that will describe the resource and begin relating that resource to the critical factors that both support and presently limit it. Without this information, alteration of the Yellowstone River, its tributaries and their present pattern of flow, is a most precipitous undertaking.

Aquatic Communities

Little is known about the aquatic communities of the Yellowstone River and its tributaries. Hence, it is necessary to obtain baseline information on the different characteristics of the aquatic habitats and communities prior to studying potential problems arising from changes in watershed characteristics and large water withdrawals.

Biologists for the Montana Department of Fish and Game have identified areas where fisheries investigations are needed, and they follow in order of priority.

First priority is given to the Tongue River drainage, Wyoming and Montana, because of its marginal flows and consequently its vulnerability. The sub-proposal suggests probing its fish populations and their habitat requirements in Tongue River Reservoir and downstream. Its estimated cost is $22,000 per year and the anticipated duration of study is two years.

The annual budget would be as follows:

Salaries and benefits	$13,000
Travel and per diem	5,000
Equipment	2,000
Rentals, materials and supplies	2,000
Annual cost	$22,000

A detailed study outline of this segment is included at the conclusion of this sub-proposal.

The second priority area of investigation would be initiating studies on the lower and middle portions of the Yellowstone River into the life histories of nonsalmonid fish now inhabiting the river. These species include paddlefish, sauger, channel catfish, burbot and others.

Investigations into the salmonid species occurring in the Upper Yellowstone are presently under investigation by the Montana Department of Fish and Game (Project FW-3-R-2).

The estimated annual cost of this project segment is $25,000 and it should be continued for at least five years. However,

it is acknowledged that meaningful data can be obtained in a two-year period. Estimated budget items for this segment are as follows:

Salaries and benefits	$16,000
Travel and per diem	5,000
Equipment	2,000
Rentals, materials and supplies	2,000
Annual cost	$25,000

The third area of priority is inventory and life history of aquatic invertebrates and forage fish supporting major fish populations in the lower and middle Yellowstone. Very little is known of these important links in the aquatic food chains and the impact flow alterations will have on them. Estimated cost of this segment is $25,000 per year. Again, while a long-term study is desirable, meaningful data can be produced over a two-year duration. Estimated annual costs are as follows:

Salaries and benefits	$13,000
Travel and per diem	4,000
Equipment	1,000
Rentals, materials and supplies	2,000
Contracted services (lab work)	5,000
Annual cost	$25,000

Migratory Bird Study of the Middle and Lower Yellowstone River

The proposed development of Montana's vast coal reserves for the production of energy in various forms will require large quantities of water, most of which is to be supplied by the Yellowstone River system. Impoundment of the main stem of the river and/or

the construction of offstream storage sites will be necessary if development is allowed to proceed to its limits. Because of the potential alteration of natural water flows in the river, it is imperative that a knowledge of the relationship of this river system to migratory birds be carefully studied, analyzed and documented.

The specifics of the study will be to: make a complete analysis of the structure and vegetation of the Yellowstone River from Big Timber to the North Dakota border, with major emphasis being placed upon the islands; determine the importance of the river system to migratory birds including geese, ducks, bald eagles, great blue herons and others; and to place the ecological productivity and importance of this river system in perspective with the Great Plains region and the nation as a whole.

Major emphasis of the study will be directed toward assessing the potential impact of altered stream flows on resident Canada goose populations, resident duck populations, resident great blue herons, migratory bald eagles, and other important migratory birds. The recreational opportunities provided by waterfowl using the river will be determined.

The structural and vegetal makeup of the river and its islands will be determined from aerial photographs and ground surveys. Extensive aerial, ground, and water surveys will be employed to gather data about resident waterfowl populations and other migratory birds using the river. Recreational use of the river and its associated waterfowl populations will be determined from hunter questionnaires.

This study should be conducted for a minimum period of two years, and preferably for three to five years. Estimated annual costs for this segment are as follows:

Salaries and benefits	$13,000
Travel and per diem	5,000
Equipment (small boat and motor, etc.)	1,500
Rentals (airplane)	6,500
Aerial photographs	3,000
Annual cost	$29,000

Furbearer Study Along the Middle and Lower Yellowstone River

The objectives of this study will be to: inventory and determine the relative abundance of furbearing mammals along the Yellowstone River from Big Timber to the North Dakota border; identify the habitat types most important to each species; assess the potential effects of seasonally altered streamflows on each species; and determine the impact of the supplemental income gathered by individuals by the trapping and sale of these animals. Major species included in the study will be beaver, muskrat, mink and river otter.

Data from this study will be gathered from intensive ground and water surveys, and supplemented with occasional aerial surveys. Each observation of a furbearer will be recorded as to location, time, date and activity, and a detailed description of the specific habitat type in which the observation was made will be recorded. Information relative to the income generated from the trapping and sale of furbearers along the river system will be gathered from trapper questionnaires, fur dealer questionnaires and personal interviews.

This study should be conducted for a minimum of one year and preferably for two years. Estimated annual costs for this segment are as follows:

Salaries and benefits	$13,000
Travel and per diem	5,000
Equipment	1,000
Rentals, materials and supplies	2,000
Annual Cost	$21,000

Total Budget - Fish and Wildlife Ecology

In viewing these proposals, it should be recognized that each study item was budgeted to be completely self-sustaining. Should all projects be funded, coordinated use of equipment and vehicles can achieve substantial savings. The sum of the five project budgets is $122,000 annually. Should all be funded, an estimated $13,000 can be saved.

Total annual budget	$109,000
Total project budget (2 years)	$218,000

Tongue River, Fish Population And Habitat Requirements

(Sample Study Outline)

I. Tongue River Reservoir.

A. Fish populations.

1. Determine indices of sport fish spawning potential through use of trap nets during spawning season.

   a. Obtain temperature data during the spawning season as related to activity.

   b. Tag and release fish and attempt to determine population strength, movements, and habitat preferences through tag returns.

2. Evaluate water withdrawals and differential stocking success between fingerling and fry plants.

3. Follow population trends of rough fish through summer gill netting.

4. Beach seine to evaluate spawning and stocking successes.

B. Inventory potential spawning areas and enhance natural reproduction.

1. Evaluate past water level manipulations and determine water level control pattern best suited for game fish production.

2. Research the abaility to improve northern pike spawning areas through planting of native grasses and fencing to exclude livestock.

C. Attempt to determine sport fishing pressure and yield statistics through a partial creel census. Gather data on fisherman characteristics for use in Phase III.

II. Tongue River.

A. Inventory fish populations of the river.

1. Establish electrofishing stations above and below the reservoir to determine species composition and distribution.

   a. Estimate population strengths through spring and fall sampling.

   b. Obtain information on movement through the use of tags.

   c. Collect scale samples for analysis of age and growth.

2. Refine other sampling methods, i.e., trap netting, seining, partial poisoning, for use in the Tongue and other streams.

B. Survey physical parameters in relation to fish populations and distribution.

   1. Water temperatures.

   2. Pool-riffle periodicity and cover.

   3. Sedimentation rates.

   4. Identify habitat alterations, riprap and channelization.

C. Limited analysis of aquatic insects.

D. Determine habitat requirements of smallmouth bass, sauger, channel catfish and rock bass and identify limiting factors.

   1. Evaluate water needs to maintain or enhance the fishery in the Tongue.

   2. Determine flow requirements for spawning and rearing of important sport fish.

Irrigation Dependent Agriculture

The purposes of this sub-project are to (1) estimate the future demand for agricultural products provided by irrigated farming; (2) to project what, if any, further irrigation development would likely occur in the study area given the existing resource base (land and water) capability in the absence of any constraints presented by coal development; and (3) having done this, it will be necessary to ascertain and quantify the possible physical and economic constraints that coal development, as a competing use of water, may create.

If coal development proceeds at the rates projected, the quantity of water consumed and the corresponding change in river stage may become factors that influence both the amount of land irrigated and efficiency of existing irrigation diversion structures to provide

water to currently irrigated lands.

Water Availability for Agriculture

To understand how coal development and related water consumption would affect irrigation agriculture in future years requires knowledge of the potential for increasing irrigated production in the region, the cropping patterns expected, and delivery system and irrigation efficiency. With this information, it is possible to calculate an average water diversion requirement per acre of irrigated land for each county, sub-basin or other desirable unit.

Data are available for various crop consumptive water requirements based on climatic conditions from representative weather stations throughout the study area. This information, together with effective precipitation factors, will be used to determine high, average and low water requirements during the growing season for specific crops.

Crop production projections and cropping pattern information are then necessary to calculate the total consumptive water requirements of various crops. Possible sources to obtain this information include: OBER's projections, projections made for the State Water Plan, or projections of the current trends from agricultural statistics.

To determine diversion requirements per acre, estimates of irrigation efficiency and delivery system efficiency are needed. The Engineering Bureau of the Water Resources Division, Department of Natural Resources and Conservation or Montana State University personnelwould be utilized to provide these figures.

The possible effects of consumptive water diversions for energy use in terms of irrigated land or crop production could then be assessed by examining remaining stream flow quantities during the growing season given some absolute minimum stream flow requirements. An outline of the analysis is as follows:

Average flows during growing season (low flow growing seasons evaluated as well).

Less - projected consumptive use of water diverted for energy development.

Equals - remaining flow available for non-energy uses

Less - minimum stream flow requirements for non-agricultural uses and needs.

Equals - average flow available for irrigation (flow available in dry years evaluated as well).

Water use figures for projected energy development will be obtainable from the Northern Great Plains Resource Program's development scenarios. Stream flow data is available from the U.S.G.S. Figures for the amount of potentially irrigated land in the study area are available from the Water Resources Division, Department of Natural Resources and Conservation and the United States Bureau of Reclamation.

Using the quantity of water available for irrigation and comparing this quantity with present and projected irrigated acres or crop requirements, an assessment of water supply adequacy can be made.

Damages to Irrigators Resulting from Industrial Water Withdrawals

Another physical constraint on irrigated agriculture is the reduction in efficiency of installed irrigation diversion structures

and delivery systems resulting from significant river flow reduction. This concern (by many of the major water users in the area) is based on the knowledge that we already experience low flow conditions in some years. They fear that such low flow conditions, coupled with large coal-related withdrawals, would substantially increase their operating costs if they were to still have their necessary irrigation water.

Consequently, this section of the effort involves a thorough reconnaissance study of present irrigation structures on the mainstem of the Yellowstone River from Big Horn to the state line, and all of Montana's portions of the Big Horn, Tongue and Powder Rivers. The study, to be done by the Water Resources Division, Montana Department of Natural Resources and Conservation, will be closely coordinated with water rights investigations going on in the area to minimize duplication and to reduce the cost of this investigation.

In order of performance, the study will progress as follows: First, a survey by a team of five irrigation technicians will survey the basin to inventory and classify all significant irrigation diversion structures. Use will be made of county water resource studies, government reports, and aerial photographs. This survey will then be followed by a review of the classified structures by an irrigation engineer. Following this, approximately 30 structures will be selected for detailed study. These will include all large projects on the system, and a random sampling of remaining projects.

stratified by size, location and type (gravity diversion and delivery system, pumped diversion to a gravity system, or pumped diversion to a pressurized sprinkler system). The detailed study of these 30 structures will be primarily carried out by the irrigation engineer with help from an economist and other specialists as needed. This study will include interviews with operators, review of project specifications, river cross-section and flow measurements as needed, and analytical wrap-up in the office.

Discussions with water rights experts suggest that the information developed in this study will be quite useful in defining when, in fact, an existing water right has been damaged. It will also be useful as the questions of minimum stream flows and the granting of additional water rights are discussed.

Water Rights Transfers

It is widely accepted that water may be a scarce and possibly a limiting factor in the growth of energy development in the region. In this regard, unsubstantiated reports have been received indicating that companies and individuals have been purchasing existing agricultural water rights or purchasing agricultural land to obtain the associated agricultural water right with the intent to eventually change the purpose of use to industrial uses. If the practice of acquiring water rights for industrial uses exists, it will have an effect on the amount of water available for agricultural purposes.

By examining state and county water rights records, it will be possible to substantiate the activity in water rights transfers.

By conducting interviews with the buyer and seller, the probable future use to which the water may be applied will be documented.

With this information, more accurate predictions of future water use trends can be made, and needs for future extensive study can be identified.

Manpower and Cost Summary

Water quantity:	
9 man months at $1,000 per month	$9,000
Employee benefits (12% of $9,000)	1,080
Travel costs	250
	$10,330
Damages to irrigation diversion efficiency resulting from flow reduction:	
Salaries	
Technician (14 man months at $600 per month)	$ 8,400
Engineer (5 man months at $1,000 per month)	5,000
Employee benefits (12% of $13,400)	1,600
Travel costs	3,000
	$18,000
Water rights transfers:	
2 man months at $1,000 per month	$ 2,000
Employee benefits (12% of $2,000)	240
Travel costs	500
	$ 2,740
Other direct costs:	
Computer time	$ 500
Publication	500
Consulting	1,000
	$ 2,000
TOTAL COST	$33,070

Municipal and Non-Energy Industrial Requirements

The purpose of this investigation is to determine the effects of various levels of water use and consumption by energy-producing industry on municipal and other industrial water supplies for the years 1985 and 2000.

This requires determining present water use and sources of supply, consumption and marketing customers, metering or measurement methods, municipal and industrial water rights, as well as storage and transportation facilities. Some of this information is now available.

Next, growth patterns will be projected for existing municipalities, including industrial users, to determine if existing water sources are adequate to fulfill projected requirements. Potential alternative sources of supply would be explored and the impact of other water uses upon these sources would be evaluated. Population projections to 1990 exist for communities in the study area. Future city water needs will be approximated from the projections.

The development and growth of new communities adjacent to the energy conversion sites and estimates of water supply required for each community will be projected. Feasible alternatives for obtaining water supplies will be evaluated for these sites.

After existing sources of water have been identified, and estimates made of the quantities of water required, the effects of industrial water storage and diversion must then be assessed for each user community. Levels of development or change can then be projected so as to predict the short-term as well as the long-term effects upon the down stream communities.

Budget

Duration of work:

Approximately 6 months.

Manpower and cost summary:

Direct salaries and wages	
Principal investigator (6 months at $1,200 per month)	$7,200
Employee benefits (12% of $7,200)	864
Travel costs	500
Other direct charges	
Publication	250
Consulting	250
	$9,064

Impact of Coal Development On Water Quality in Montana

This study will be a two-year intensive investigation of existing and potential impacts of coal development on water quality in Eastern Montana. Massive coal development will create a variety of potential water pollution challenges and will require an increased water quality management effort in this part of Montana. Specific items that will be addressed in this proposed investigation are:

1. Gathering of baseline water quality data.
2. Water quality problems directly associated with mining.
3. Influence of stream dewatering on water quality.
4. Evaluation of adequacy of the state's regulatory framework.
5. Assessment of needs to prevent water pollution.

This project is to develop a comprehensive picture of water quality in the Yellowstone Basin of Eastern Montana. The probable direct impacts of coal development on water quality will be assessed and the adequacy of the existing regulatory framework to control pollution will be examined. Only after new pollution loads are evaluated can one determine the extent to which industrial water use will affect water quality by lowering the dilution factor.

The investigation will utilize, as much as possible, existing data from the area. Present studies by the U.S. Geological Survey, Water Quality Bureau, Montana Bureau of Mines and Geology, Northern Great Plains Resource Program, the RALI project and information from private companies will be utilized. Most of such data related to the effects of strip mining on groundwater quality.

Baseline Water Quality

The basic quality of all significant stream and other water bodies in the area will be determined. Previous investigations provide data on some streams and these data will be evaluated to determine what additional measured parameters are necessary to define baseline conditions. For example, sediment data are scarce for this part of Montana and existing programs are not providing sufficient data to document current sediment levels. Needed water quality parameters are: major and secondary constituents, metals, nutrients, sediment, temperature, DO, BOD and coliform organisms. Sampling programs will be designed to determine seasonal variations in these parameters. All analyses will be done in the Montana Department of Health laboratory or, where appropriate, in the field.

Quality Problems Associated with Mining and Energy Conversion

The potential effects of mining on water quality will be determined. Information from operations in Montana and adjacent states will be evaluated to assess possible problems that may result from the coal development. Many potentially important pollution sources such as gasification plants have not operated in the Fort Union Region. Water pollution problems associated with such operations will have to be assessed from the nature of the operation and its water processing methods as proposed in North Dakota and New Mexico.

Reclamation of stripped lands has not been demonstrated except on small plots. Potential water pollution problems from vast stripped areas will be considered. Erosion, sedimentation, increases in dissolved minerals and metals are problems attendant to strip mining operations.

Existing and potential influences of coal development on groundwater will be evaluated to determine if significant problems will occur. Some mine site groundwater quality data are now available. The relationship between saline spoil water and the quality of nearby streams, however, is poorly understood and will be addressed by this study.

State Regulatory Framework

Montana has a number of laws and regulations that are thought to be adequate to control water pollution. These legal controls have not been tested in court and a comprehensive review of our pollution statutes and regulations should be made to insure their adequacy in enforcement problems in Eastern Montana. The question of regulatory authority on Indian lands and on interstate waters also must be examined. Montana will be taking over the federal discharge permit program in 1974. The adequacy of proposed permit regulations must be reviewed in light of enforcement actions that may be required in coal development problems.

The basic question to be answered is whether or not Montana has the requisite legal framework to control water pollution from coal developments.

Assessment of Needs to Prevent Water Pollution

Coal developments will require additional state effort in water quality management planning, monitoring and surveillance, enforcement, waste discharge permits and facilities construction, operation and maintenance grants. All these elements of a comprehensive pollution control program may require additional funds and personnel. An appraisal of such impacts must be made to allow the state to prepare for these added responsibilities.

Influence of Stream Dewatering

Reduction of stream flow will influence water quality due to dilution changes. Results of waste water inventories in the area completed by the Water Quality Bureau will be combined with projected increases (decreases?) in pollution loads and compared with proposed stream flow changes to assess potential impacts on in-stream water quality on a seasonal basis. Dewatering can adversely affect water chemistry, temperature, sedimentation processes and biological productivity. This work will continue into the impact evaluation portion of Phase II.

Duration of the Investigation: 30 Months

Personnel:

Project Leader (1.5 man years at $14,000 per man year)	$21,000
Project Assistant (1.5 man years at $11,000 per man year)	16,500
Laboratory Analyst (2.0 man years at $11,000 per man year)	22,000

Attorney (0.4 man years at $17,000 per man year)	6,800	
Secretary (0.5 man years at $7,000 per man year)	3,500	
	$69,800	
Employee benefits (12%)	8,376	
	$78,176	
Travel and Per Diem:		
40,000 miles at 12¢ per mile	$4,800	
200 days at $16 per day	3,200	
Out of state travel (4 trips air fare)	800	
Per Diem (12 days at $25 per day)	300	
	$9,100	
Computer Time:		
30 hours at $110 per hour	$3,300	
Equipment:		
Portable pH meters (2)	$ 900	
Atomic absorption tubes	1,000	
Sediment sampling apparatus	1,500	
Conductance bridges (2)	800	
Turbidity meters (2)	700	
Flow gaging equipment (2 meters)	500	
Laboratory spectrophotometer	1,800	
Millipore apparatus	1,500	
Auto analyzer accessories	5,000	
Glassware and expendable materials	3,000	
Automatic samplers (2)	2,500	
	$19,200	
Total Equipment		$ 19,200
Project Total		109,776
Contingency		5,000
TOTAL		$114,776

Water Based Recreation

Information on recreation use of the Yellowstone River in the study area is fragmented and incomplete. Aspects of recreation use such as fishing and waterfowl hunting are known through license sales; however, it is difficult to relate this information to specific sections of the river and drainage areas. The lack of developed sites on much of the area makes it difficult to quantify dispersed uses such as camping and floating without field study.

The recreation use information would be obtained consequently in two major components, analysis of existing records, and field investigations. This would be followed by correlation with the information anticipated to be provided by other study segments relating to hydrologic matters. An outlined plan of work follows:

Task 1

Compile information on current recreation usage of Yellowstone study area in terms of volume, type and geographic location.

A. Review of existing information.

   1. Evaluation of hunting and fishing license sales, creel census data, fishing pressure data, park and recreation area usage data, plus game management based information.

   2. Determination of additional field information needed.

B. Acquisition of new information.

   1. Undertake field studies to relate recreation usage to given segments of the Yellowstone and to the volume and quality of water flow.

2. Coordinate and derive information from a fishing pressure survey to be carried out under the state recreation planning program (already funded).

3. Coordinate and derive information from demand studies to be carried out by the comprehensive planning program for recreation, fish and wildlife.

4. Estimate optimum current recreation potential.

Task 2

Obtain information on potential changes in water flow levels.

A. Derive information from other studies (hydrology) which will indicate approximate water flow levels as related to consumption and diversion.

B. Mapping and graphics related to this information.

Task 3

Conduct field studies to predict changes in recreation potential due to change in water flow.

A. On-site investigation throughout the season on typical segments of streams.

Task 4

Field evaluation of alternative sites for recreation potential (preparation for projected population increases and accompanying rising demands for recreational opportunities).

A. Study of comparable resources not within the study area.

B. Study of water resource areas which have been suggested for development.

Budget

It is estimated that the total cost would amount to $36,584 as follows:

Major investigator	$12,000
Student assistants	12,200
Major investigator (2nd year - 1/2 time)	6,000
Total Salaries	$28,200
Employee benefits	3,384
Travel and per diem	5,000
TOTAL COST	$36,584

Hydrology Study, Yellowstone River and Major Tributaries

Purposes

1. To study stream channel processes and dynamics at various discharge rates and to determine the effect extensive diversions, storage projects and other flow alterations would have on channel stability and process.

2. To provide hydrologic expertise to the other investigators of Phase I and to provide hydrologic input to the computer modeling of Phase II.

Methodology

1. Preparation work.

A. Review existing stream flow data and transpose selected records from tabular to graphic form. This is to provide low flow frequency, low flow duration and other data in a form useable to the other disciplines in the Phase I investigations.

B. Assess additional hydrologic data needs and recommend data acquisition programs.

2. Field work.

A. Using procedures developed by the U.S. Geological Survey, establish vigil sites on several representative reaches of the Yellowstone River and major tributaries.

B. Measure or obtain all relevant channel and flow characteristics at each vigil site under a variety of discharge rates.

C. Observe changes in erosion and sedimentation rates as a function of flow rate so that the consequences of possible long-term changes in historical flow patterns may be evaluated (to be done in conjunction with water quality investigators).

Synthesis

1. Provide correlations between discharge and channel characteristics useful to other investigators involved with irrigation, fisheries, aquatic life and recreation. For example, biologists studying impacts of water use upon the fish food chain would greatly benefit from a reliable correlation between discharge and total wetted channel surface. Similarly, those concerned with irrigation efficiencies will need a correlation between discharge and stage.

2. Work closely with the computor modeling program (Phase II) of this proposal by providing data and by assuring that the calibrated basin model provides evaluations in a form useful to all other investigators.

Participants

With the exception of the vigil site work, which will be done by graduate students from the Department of Geology, University of Montana, all of the activities will be conducted within the Water Resources Division, Montana Department of Natural Resources and Conservation (DNR&C). Current meters, surveying instruments and other equipment necessary for the vigil site work can be borrowed from the U.S. Geological Survey.

Budget

Department of Natural Resources and Conservation

Direct salaries and wages:

Phase I (1½ years)		
Professional (hydrologist) 18 man months at $1,200 per month	$21,600	
Employee benefits (12% of $21,600)	2,592	
Consultant	500	
	$24,692	
Phase II (½ year - model calibration and basin simulation)		
Professional (hydrologist) 6 man months at $1,200 per month	$ 7,200	
Employee benefits	864	
Consultant	250	
	$ 8,314	
Travel costs (mileage and per diem)	$ 1,000	
Other direct costs		
Computer costs	$ 1,000	
Publication and typing	500	
	$ 1,500	
TOTAL COSTS		$35,506

Graduate Students

Direct salaries and wages:

Graduate assistantship - one year	$4,000	
Graduate student and two field assistants for one full summer (surveying and establishing vigil sites) 3 months each at $500 per month.	4,500	
Employee benefits (12%)	1,020	
	$9,520	
Travel costs (5,000 miles at 12¢ per mile plus 150 man days in the field at $16 per day)	$3,000	
Publication	$ 500	
TOTAL COSTS	$13,020	
TOTAL FOR ENTIRE PROJECT		$48,526

Phase II - Water Model Calibration, River Basin Simulation and Impact Evaluation

This phase will apply the knowledge gained in Phase I to help answer impact questions concerning changes in water flow.

Using sets of various predetermined conditions and the State of Montana water planning model, flow and climatic conditions can be simulated for the Yellowstone Basin and/or each of the sub-basins described further on in this report. Each of the Phase I investigators will then use their field data to quantify what could happen regarding their areas of concern.

Under certain assumed levels of consumption, the flow remaining will have to be allocated among competing users. For example, there

For example, there may be sufficient flow to adequately supply projected irrigation requirements but insufficient remaining flow to sustain aquatic communities. These conflicts would be identified and quantified to the extent possible under the knowledge acquired from the investigations in Phase I.

This phase of the study will quantify insofar as possible interrelated impacts of various possibilities regarding: water storage and diversion, water requirements and climatic conditions. Impacts and conflicting competing uses of water will be evaluated for the years 1985 and 2000, in the following manner:

Predetermined Conditions 1985 - 2000

- Water use requirements (all competing uses)
- Aquatic community requirements
- Hydrologic (diversions and storage)
- Climatic data

Analysis

Water Model Simulations
Knowledge From Field Studies

Consequences

- Sufficient flow for all users and aquatic systems?
- What user would suffer and how would that use be affected?
- Would aquatic systems suffer?
- What would be the effects of additional water storage projects?

Results would be published, presenting hydrologic assumptions, flow conditions and possible impacts in the following manner:

1985 - Case I	Basin	Simulated Flow	Impacts, Etc.
Predetermined conditions	Total Yellowstone Basin		Aquatic Biology
Hydrologic & climatic conditions	Sub-Basin 43A		Irrigation
Direct diversions	43B		City Water
Off stream storage	.		
Dams	.		Water
Predetermined water users	.		Quality
Population projections	.		
Irrigated acres	.		Recreation
Aquatic communities	43N		

This type of portrayal will be made for each set of assumptions modeled for each time period.

To accomplish Phase II, the principal investigators of Phase I will (1) agree upon the various predetermined conditions to be modeled; (2) use the water planning model to simulate these conditions; and (3) evaluate the consequences, identifying conflicts arising, and describe the consequences in quantifiable parameters based on the knowledge obtained in Phase I. The Northern Great Plains Resource Council "interim" report and the products of the OWRR grants will be heavily relied upon in determining industrial water demands to be incorporated into the modeling program.

The simulations will be performed by the hydrologist in charge of the hydrologic investigation in Phase I. Also involved in the impact evaluation and subsequent report will be the resource economist assigned to the coordinator's office.

Water Model Calibration and River Basin Simulation

The water planning model will use historical flow data, climatic variables and given water use assumptions to predict resulting discharge variations on a monthly basis. This mathematical model was developed

for the Montana Department of Natural Resources and Conservation by researchers at Montana State University. It deals in water quantities by solving a series of equations with a digital computer. The model is intended as a tool to enhance the state's water planning and management capabilities.

The model provides rapid and accurate answers to questions such as: "How will the Yellowstone River's discharge at Glendive be affected by the steady-state withdrawal of 39,000 acre feet of water above Forsyth? The use of 80,500 feet of stored flood water at Moorhead? Both withdrawals?" The model's strength is that it can evaluate almost any combination of water use levels, locations of withdrawal and types and timing of diversion. It should be made clear that the evaluations will only predict discharges at points downstream under a variety of weather patterns (wet year, dry year, average year). The model itself will not document what given modified discharges mean to competing water uses. That is for the Phase I researchers, especially the hydrologist.

Three versions of analysis are within the capability of the model: statewide, basin and sub-basin. The sub-basin model is the most comprehensive version, providing the greatest detail. The Yellowstone drainage basin and one of its sub-basins were used in the model development; subsequent basins or sub-basins have not been calibrated.

Certain data are available for these sub-basins in a form usable by the model. These include stream flows, precipitation, temperatures, evaportation, reservoir storage and basin areas. Other data

required by sub-basin are irrigated and non-irrigated crop acres; soil classifications by acres and areas; irrigation or other diversions; and, imports from other basins for all years for which data exists. Some manipulation of existing data will also be required.

Model calibration involves computer runs utilizing primary data as input to determine secondary values. These secondary values are then used as input to simulate situations for which response can be easily predicted. If the results are not satisfactory, educated trial and error adjustments must be made to parameter coefficients until results are acceptable. Once this is done, simulation of desired situations can start.

Simulation requires determination of the water use scenarios to be simulated and adjustments made to the model and input data to accommodate changes in parameters to be simulated. After the computer runs are made, the results are studied for reasonableness and, if necessary, rerun after modifications are made. At least one simulation run will be necessary for each level of water use and set of interrelated factors for each sub-basin or area.

Excluding the one sub-basin already calibrated, there are 13 sub-basins in need of calibration. An estimated four man months will be required to calibrate the first sub-basin. The remaining sub-basins will require an estimated three man months each for a total of 40 man months. This includes data gathering and preparation. Total calibration and simulation costs are estimated as follows:

Budget

Direct Salaries and Wages	
Principal investigator (20 man months at $1,300 per month)	$26,000
Assistant (20 man months at $900 per month)	18,000
Employee benefits (12% of $44,000)	5,280
Expendable equipment and supplies	500
Travel	1,500
Other direct charges	
Publication	1,000
University consultants	4,000
Computer costs (Montana State University computer)	8,510
TOTAL	$64,790

Once the major work of calibrating the sub-basins is accomplished for this project, water managers in government, private industry, and university researchers would be able to use the model for the middle and lower Yellowstone Basin.

It should be noted that the researchers from Montana State University who originally developed the model have recognized the need to use the model for the Yellowstone Basin and have submitted a proposal to the National Science Foundation (RANN Division) to calibrate three of the subject sub-basins. If their proposal to NSF is funded, this Phase II budget could be reduced by approximately $6,400.

Impact Evaluation

The Impact Evaluation part of Phase II will be commenced while Phase I is nearing completion. The impact evaluation cannot be

completed, however, until the results of the Phase I studies are available in useable form.

The impact assessment process involves three stages:

1. Determine the mix(es) of coal-based water consumption to be evaluated in the years 1985 and 2000.

2. Project the demands that other water users will impose in the subject years. (It is likely that municipal and irrigation demands will increase and that in-stream biologic needs will remain constant. Future flows required to dilute pollutants will also be projected.)

3. Given 1 and 2 above, impacts on each competing demand will be quantified by the Phase I investigators using data gathered by Phase I. Specifically, each investigator will identify and describe possible impacts of new flow regimes on his area of concern. The investigators will work together to identify and define conflicts arising among the various water users and between the water users and natural biologic and hydrologic systems.

Duration of Work

Approximately six months.

Budget

Direct salaries and wages	
Eighteen man months -- 6 principal investigators from Phase I at $1,200 per man month	$21,600
Employee benefits (12% of $21,600)	2,592
Other direct charges	
Computer (included in cost summary for water model calibration and simulation	- 0 -

Publication	1,500
Outside assistance	1,500
TOTAL	$27,192

Phase III Economic Analysis

Water, in the stream or diverted and consumed, has a spectrum of uses and corresponding values. Some of these values are mostly of a private nature -- such as irrigation or an industrial process. Other values are mostly public (social) -- such as stream flow maintenance for aquatic life-systems. As decisions are made for the allocation of water to the various public and private uses, the value of water in alternative uses becomes very important.

This proposed economic analysis is intended to be a major unifying force for the overall project. It will bring together and utilize the work and findings of Phases I and II.

Phase III will quantify insofar as possible, the economic values of water use impacts resulting from the consumption of various amounts of water for new coal-based industries. Possible benefits to certain water uses will be quantified as well.

The analysis will provide a structure within which decision-makers can deal with water use conflicts and tradeoffs associated with foreseeable water use configurations. The analysis will be of significant assistance to federal and state officials charged with calculating cost/benefit ratios for proposed water diversion and/or storage projects.

Phase III activities will be directed by an economist serving full time with the coordinator of the entire project (see coordination section). Such an arrangement is chosen to assure that the results of the field investigations (Phase I) and computer modeling and impact evaluations (Phase II) readily lend themselves to summation by economic analysis. The steps proposed to develop the economic analysis are detailed under "economist" in the following coordination section.

Budget

Three-thousand dollars ($3,000) are requested for contingency consultant needs. All other Phase III expenses appear in the coordination budget.

Coordination

A project of this magnitude and duration surely requires full-time coordination. As soon as funds are known to be available, the Montana Energy Advisory Council will interview a number of likely candidates for the coordinator's position. The coordinator should have broad based experience in natural resource investigations, familiarity with stream processes and certainly some administrative experience. A project flow chart is attached as Appendix D.

Some of the more obvious tasks for the coordinator are:

1. Assist in personnel selection.
2. Assure that unnecessary overlaps of the six field investigations are avoided.
3. Insure a constant flow of information between Phase I studies.

4. Promote sharing of transportation and equipment.

5. Keep Phase I investigators "on track", i.e., assure that the field measurements and observations lend themselves to the impact analyses of Phase II.

6. Arrange a common format for the Phase I reports.

7. Assure that basin modeling activities (Phase II) can be coupled with the vigil site observations to provide projected stream data in a form useful to the investigators of Phase I.

8. Assemble all investigators as a "think tank" to perform the impact evaluation part of Phase III.

9. Supervise preparation of a final report.

10. Control cash flow throughout the project.

The coordinator shall be assisted full time by a resource economist whose primary duty will be to conduct the economic evaluations of Phase III. The economist needs to be party to all earlier activities, however, so that the results of the first two phases lend themselves to economic analysis. The economist shall:

1. Provide guidance to all Phase I and Phase II studies.

2. Directly assist the irrigation dependent study by providing probable price ranges for regionally important agricultural products in the years 1985 and 2000. In turn, crop production projections and other economic indicators will be used to project regional increases or decreases in demands for irrigation water.

3. Conduct and solicit research regarding quantification of impacts that are not readily expressed in economic terms. Example: water based recreation.

4. Perform economic analysis of positive and negative impacts of all water use configurations modeled.

5. Assist on preparation of final report.

Budget

Most of the field studies will continue for two years. The model calibration and basin simulation activities of Phase II will commence soon after the start of Phase I. It is assumed that the impact evaluation portion of Phase II and Phase III's economic analysis will require less than a full year. Three years of coordination funds are requested to allow the coordinator to be at work prior to beginning Phase I.

	First Year	Three Years
Salaries		
Coordinator	$18,000	$54,000
Economist	14,000	42,000
Secretary (half time)	3,500	10,500
Employee benefits (12% of $106,000	4,260	12,780
Travel and per diem	1,700	5,100
Supplies and materials	500	1,500
Xerox and postage	600	1,800
Publication of final report		4,000
TOTAL	$42,560	$131,180

Budgetary Note

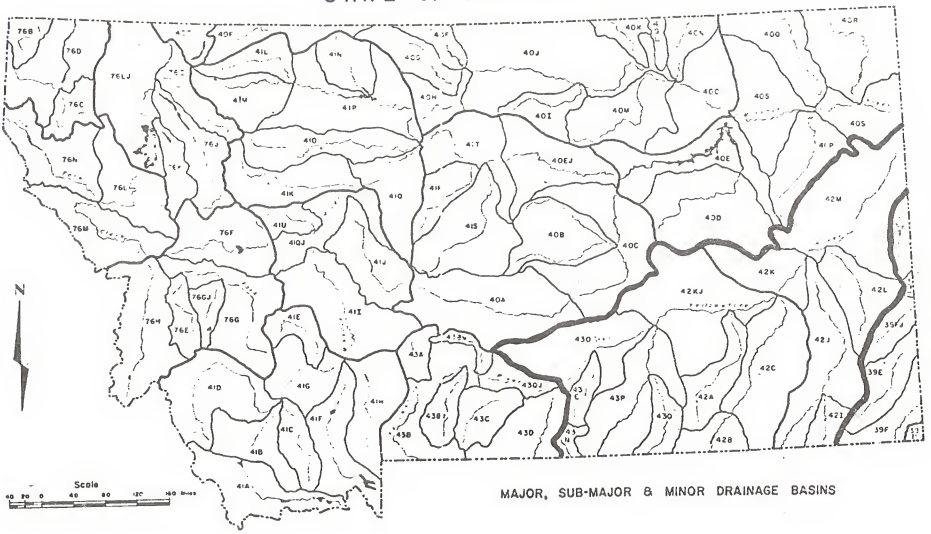
The $18,000 coordinator's salary is hopefully sufficient to attract an experienced federal employee if after interviews, such a person is found best suited for the position. It is surely adequate to compensate almost any federal official if his salary is shared by the state and his "parent" federal agency.

It should also be noted that $18,000 is significantly in excess of the salaries of those Montana State employees who prepared this proposal. If any of these people should serve as coordinator, that person would expect only standard cost of living pay raises and $2,500 to $4,000 in salaries and benefits would be saved annually.

Total Proposed Budget

	Year 1	Year 2	Year 3	Three Year Total
Phase I				
Fish and wildlife ecology	109,000	109,000		218,000
Irrigation agriculture	16,285	16,785		33,070
Municipal water	9,064			9,064
Water quality	63,488	44,288		107,776
Recreation	24,389	12,195		36,584
Hydrologic studies	30,773	17,753		48,526
Phase II				
Calibration and simulation	32,395	32,395		64,790
Impact evaluation		13,596	13,596	27,192
Phase III				
Consulting	3,000			3,000
Coordination	42,560	42,560	46,560	131,680
TOTALS	$330,954	$288,512	$60,156	$679,68[illegible]

STATE OF MONTANA

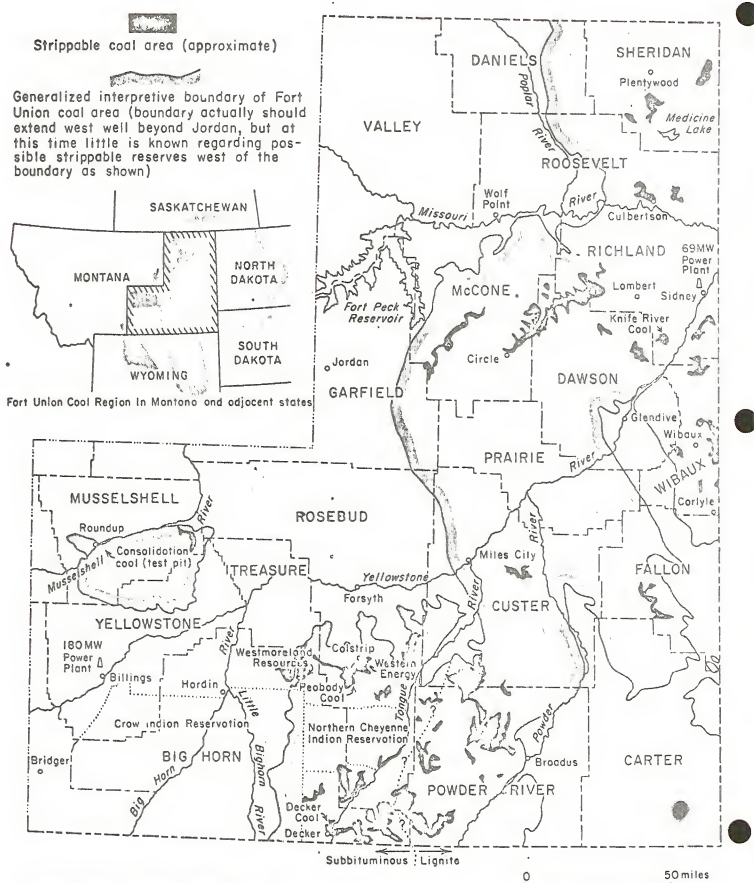


APPENDIX A

STUDY AREA

FORT UNION COAL AREA IN EASTERN MONTANA

APPENDIX B



Source: Montana Bureau of Mines & Geology

An Armchair Excursion into the Diversified
Operation of an Irrigated Farm Unit

Presented To
Lower Yellowstone River Workshop
October 24, 1973
Miles City, Montana

By: Willie Day, Buffalo Rapids Irrigation District

My intent today is to give you an insight into an irrigated farm unit as an integral part of a working Federal Irrigation Project, and to provide some realisitc bread and butter figures that will show the intimate and very productive relationship between irrigated agriculture and its natural water supply in this area.

For a start, let's look at my operation which amounts to approximately 300 acres and grosses about $69,500. In addition, let's figure how much land would be needed to produce the same gross income without irrigation.

Crop	'73 Mrkt. Price	Irrigated Acres	Yield	Gross	Dryland Acres	Yield	Gross
Corn Silage	$11/T	90	20T	$19,800	360	5T	$19,800
Sugar Beets	$17/T	95	20T	32,300	None	(Wheat)	
Beet Tops				1,900			
Alfalfa	$30/T	70	4-1/2T	9,500	210	1-1/2T	9,500
Pasture	$.60 lb. of gain	10	200#	1,200	100	20#	1,200
Wheat	$4.50/bu.	15	45bu.	3,000	470	35bu.	38,000
Oats	$1.00/bu.	20	90bu.	1,800	60	60bu.	1,800
		300		$69,500	1200		$70,300

From this one comparison we can see that irrigated agriculture makes a real impact on Montana's #1 industry in terms of intensity, efficiency, and most of all stability of income year after year. Without water at the proper time these ingredients are lost. In fact, our greatest concern is the timing of water delivery. The greatest demand on our project is from the last week of June until the middle of August. This corresponds with the low period in the river during July and August. As you can see, average flow figures per season do not do us a bit of good. You can average the air you breathe per year too, but have

it shut off for five minutes during that time and the result would be the same as missing a months water on our project.

Even small industrial diversions will hurt us drastically without supplemental low flow regulation.

This was demonstrated in 1961 and again in 1966 when water had to be severely rationed because of low stream flow. In terms of cost we couldn't irrigate the hay ground for part of the second cutting and all of the third, losing 1-1/2 tons per acre. At $30/T this is $45/A or $3,150 on our farm in the chart. And this is on the crop least susceptible to damage at a time of no industrial development.

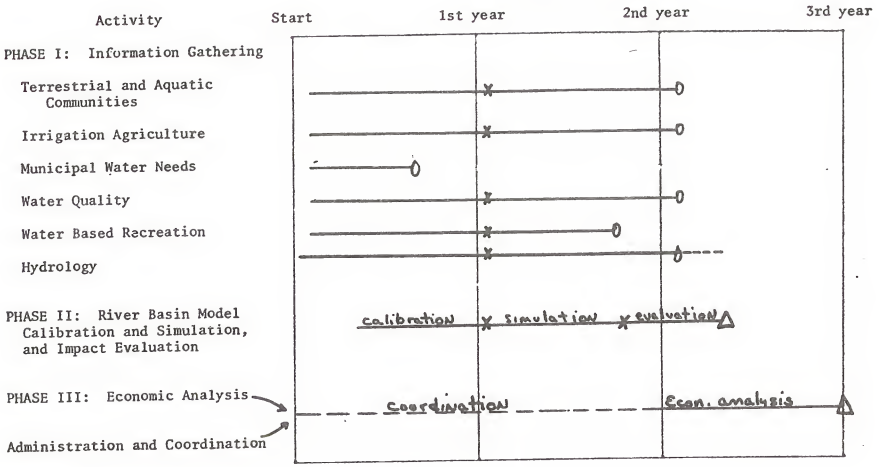
We believe that there are courses of action that are necessary in the future to insure that agriculture is not damaged as our No. 1 industry, now three times as large as No. 2, and larger than all other combined.

1. A priority of water use should be established in the state in the order of: domestic; municipal; agriculture; recreation and industry.

2. That a minimum efficiency flow relative to existing projects be established and maintained by whatever means feasible.

In addition, we feel that the new industry that will benefit most should have to bear the cost of maintaining these efficiency flows. If we are indeed in an energy crisis, then agriculture should not have to also bear the cost of meeting that crisis. It should, in fact, be borne by the energy industry.

To help implement this course of action we have formed a water users association on the Lower Yellowstone of which I am serving as Ad Hoc Chairman.

In closing, I would like to say that we are not against development that would help all of Eastern Montana. We are against development that will hamstring those industries already in existence.

SCHEMATIC REPRESENTATION OF PROJECT SCHEDULE